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EXAMINER	
DAGER, JONATHAN M	

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3663	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/573,410	BITAR ET AL.	
	Examiner	**Art Unit**	
	JONATHAN M. DAGER	3663	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *21 November 2008*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-11* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-11* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *25 March 2009*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

1. Applicant's arguments, see pages 6-9, filed 21 November 2008, with respect to the rejection of claim 1 under 35 U.S.C. 103(a) have been fully considered and are persuasive. Therefore, the rejection of claim 1 under 35 U.S.C. 103(a) has been withdrawn.

Subsequently, the prior art rejections of all claims dependent therefrom are withdrawn.

However, upon further consideration, new grounds of rejection are warranted (see below).

Claim Rejections - 35 USC § 103

2. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

3. Claims 1-4, and 6-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zoraster (US 5,839,090), and further in view of Mitchell ("An Algorithmic Approach to Some Problems in Terrain Navigation, hereinafter "Mitchell 1986") and Tran (US 5,892,462).

Regarding claims 1 and 6-9, Zoraster discloses a transform gridding method using distance, in which high quality geologic interpretations are incorporated onto computer generated contours. The method starts with a trend form grid on which characteristics of geological formations are superimposed. Contours of such characteristics with respect to the trend form grid are generated using a distance transformation (abstract).

Further, Zoraster discloses distance transforms in image processing via application of a mask over various points in an image, and then estimation of a distance to a point, from using

well established methods, including the known works of Borgefors (column 1 lines 26-67, and column 2 lines 1-30)

In the current application, the applicant has provided in the specification multiple citations on well known methods of distance transformations and scanning methods (claims 6-9) on displayed images.

For example, as stated in paragraphs 0005 and 0006 of Applicant's published specification:

“Distance transforms operating by propagation also known as "chamfer distance transforms" or "chamfer Euclidean distance transforms" deduce the distance of a pixel termed the goal pixel with respect to another pixel termed the source pixel, from the distances previously estimated for the pixels of its neighborhood, through a scan of the pixels of the image. The scan makes it possible to estimate the distance of a new goal pixel with respect to the source pixel by searching for the path of minimum length going from the new goal pixel to the source pixel passing through an intermediate pixel of its neighborhood whose distance has already been estimated, the distance of the new goal pixel to an intermediate pixel of its neighborhood whose distance has already been estimated being given by applying a neighborhood mask commonly called a chamfer mask.

A distance transform of this kind was proposed in 1986 by Gunilla Borgefors for estimating distances between objects in a digital image, in an article entitled: "Distance Transformation in Digital Images" and published in the journal "Computer Vision, Graphics and Image Processing", Vol. 34 pp. 344-378. One of the interesting benefits of these propagation-based distance transforms is of reducing the complexity of the calculations of a distance estimate by permitting the use of integers.”

Further, paragraph 0007 of the published specification reads:

“To select the path of minimum length giving the distance estimate, a propagation-based distance transform must test all the possible paths. This obligation is manifested as a regularity constraint imposed on the order of scanning of the pixels of an image. G. Borgefors proposes, in order to satisfy this regularity constraint, that the pixels of an image be scanned twice consecutively, in two mutually inverse orders, which are either lexicographic order, the image being analyzed from left to right row by row and from top to bottom, and inverse lexicographic order, or transposed lexicographic order, the image having undergone a 90.degree. rotation, and inverse transposed lexicographic order. She also proposes the adoption of a chamfer mask of dimensions 3.times.3 with two values (3, 4) of neighborhood distances or of dimensions 5.times.5 with three values (5, 7, 11) of neighborhood distances.”

Paragraph 0043, last line, affirms the above:

"G. Borgefors advocates a double scan of the pixels of the image, once in lexicographic order and another time in inverse lexicographic order."

The specification further adds (para 0047),

"For terrain navigation of mobile objects such as robots, the propagation-based distance transform is used to estimate the distances of the points of the changing terrain map extracted from a database of elevation of the terrain with respect to the position of the mobile object or a close position. In this case, it is known to take account of static constraints consisting of map zones that the mobile object cannot cross on account of their undulating configurations."

Zoraster further adds that distance transformations have been applied in fields outside image processing and robotics including pattern recognition and terrain navigation. K. L. Clarkson described such an application in 1987 in a paper Approximation Algorithms for Shortest Path Motion Planning, Proc. 19 Ann. ACM Symp Theory Computers, pp. 56-65. Distance transformations have been adapted to select paths for vehicles, people, or robots around obstacles. They have also been used for navigation or path planning over terrain. In terrain navigation applications the terrain is divided in non-overlapping regions. Each region has a cost for movement through it. J. S. B. Mitchell describes such technique in a 1988 paper, An Algorithmic Approach to Solve Problems in Terrain Navigation, Artificial Intelligence, Vol. 37, pp. 171-201. To apply distance transformations to the terrain navigation problem requires only a small amount of added complexity. First, the C(i,j)'s become general cost factors such as time, instead of distance. Second, the values of the C(i,j) are made a function of the terrain at the operator position. Pixels which are difficult to travel through have large costs associated with them. In a simple navigation problem the pixel costs might be proportional to the slope of the terrain. In a military application, open terrain subject to enemy observation might have an additional cost factor associated with it (column 2 lines 55-67, column 3 lines 1-13).

Thus, from the above citation, Zoraster discloses a method for estimating the distances from a mobile object to the points of a map of a terrain over which the mobile object is moving, said map being derived from a terrain database, gridding (equivalent to "meshing", as claimed), Zoraster is stating that in searching for the shortest path, it is known to utilize time derived by length to the mobile object, as well as setting a goal point in the prohibited zone. Zoraster, and the above cited passages from the Applicant's specification also provide for the distance estimation of a point, as claimed, by a chamfer mask. However, what Zoraster does not explicitly teach is the process wherein if a goal point is in a prohibited zone, the point is excluded from the search for the shortest path. Rather, Zoraster, citing the known works of Mitchell, teaches utilizing an increased time factor in weighting if the catalogued point belongs in a prohibited zone of travel.

Further, the Applicant's specification citing the known works of Borgefors, combined with the above as-cited known Mitchell 1988 paper are directed to static, not dynamic constraints; static constraints do not change with time.

Lastly, the above citations provide for selecting the shortest (timewise) path.

In Joseph B. Mitchell's 1986 paper entitled "An Algorithmic Approach to Some Problems in Terrain Navigation" (hereinafter "Mitchell 1986"), Mitchell 1986 examines the path planning problem in which we are given a "map" of a region of terrain and we are expected to find optimal paths from one point to another. This, for example, is a task which must be done repeatedly for the guidance of an autonomous vehicle. We examine how to formulate some path planning problems precisely, and we report algorithms to solve certain special cases (abstract).

Thus, Mitchell 1986 teaches finding the optimal (shortest path) when route planning for terrain navigation.

Mitchell 1986 teaches that usually, the robot has some knowledge (which we refer to as a map) of the terrain on which it is navigating (page 1, section 1). Mitchell 1986 provides an example of determining the shortest path on a nonplanar (3D) surface, which is called a "Discrete Geodesic Problem", starting on page 8.

To start, Mitchell 1986 teaches that possible surface representation that is often used in practice is that of contour lines. We might be given a set of iso-elevation curves, as is usually the case with geological maps of terrain. A third common representation is that of an elevation array. In this case, we are simply given a two-dimensional array of numbers which represent the altitude at each grid point. Digital terrain data bases of the form compiled by the Defense Mapping Agency (now the NGA) fall into this category. (Typically, pixels are of size 5, 12.5, or 100 meters.) These are just some of the methods of specifying a discrete approximation of a surface (see page 8, last paragraph and page 9, first paragraph).

Thus, Mitchell 1986 teaches modeling using a digital terrain database, meshing the terrain of deployment of the mobile object. For more information on the digital terrain data base, see

https://www1.nga.mil/ProductsServices/TopographicalTerrestrial/DigitalTerrainElevationData/Pages/default.aspx ,

and

http://geoengine.nga.mil/geospatial/SW_TOOLS/NIMAMUSE/webinter/dted0_legend.html , for further information on geographic coordinates and altitude data provided by the DTED.

As a second example of a navigating a mobile vehicle through a terrain, Mitchell 1986 uses an example entitled the "Weighted Region Problem" (starting on page 10, item 4). It is a generalization of the obstacle-avoidance problem in the plane, for the obstacle-avoidance problem is simply the weighted region problem in which the "weights" are either 1 or +infinity depending on whether a region is "free space" or obstacle, respectively. Thus, an important theoretical reason for considering the weighted region problem is that it is a natural generalization of the well-studied obstacle-avoidance problem.

Basically, the ground surface is subdivided into uniform regions, with a label (or some traversability index) attached to each region which gives information about how fast one can move in that region (or how costly it is to do so). Presumably, the robot can move through different types of terrain at different speeds. Speeds may also depend on other factors such as time of day, precipitation, or the location of other vehicles; however, we assume that a given problem instance has fixed weights. In military applications, there may be regions which correspond to high threat risk, perhaps because the enemy has good visibility of you when you are in these regions. Costs can be assigned to traveling in these risky regions as well.

We will discuss two basic types of map representations: regular tesselations (e.g., grids of pixels, or quadtrees), and straight-line planar subdivisions.

Representing terrain in the form of a regular grid of pixels is natural and simple. Figure 4 shows the map of Figure **3** in digitized form, on a grid of size 26-by-40 (1040 pixels).

Frequently, terrain data is given in the form of a set of arrays, with each array giving information about some aspect of the terrain (e.g., ground cover, land usage, hydrography data, man-made features, and traversability indices). This, for example, is the form in which the Defense Mapping Agency terrain data is supplied. Pixels are usually squares 5, 12.5, or 100 meters on a side. From this type of data, we can specify the map by taking the superposition of all the data arrays to form one composite map (a "terrain array"), whose regions of equal attributes will have descriptions such as "brush-covered, drainage plain", or "forested land, sandy soil, small boulders". Each composite region may be assigned a weight representing the cost of motion in that type of terrain. Certain types of terrain features have priority over others. For example, if the "roads array" tells us there is a road surface occupying pixel (i, j), while the ground-cover array describes the pixel as "grassland", then the composite region attribute at (i, j) should say that there is a road there (page 11 third paragraph, through page 12 first paragraph).

Mitchell 1986 notes that if an edge is a line segment of a ditch or a fence, then it may be assigned a fixed cost of crossing it. The fixed cost would be $+oo$ if the edge cannot be crossed (page 13 second paragraph last line).

In this way, Mitchell 1986 is describing how a goal point is excluded from the search from the shortest path if it is located in an area that is prohibited. It is also noted from above that it is suggested that these constraints are indeed dynamic with respect to the mobile object, in that Mitchell does state in the above that the configuration of the map may differ as a function of time of travel of the mobile object.

The invention of Zoraster is drawn to constructing digital, grid-based models of the earth in three dimensions. Zoraster has disclosed that the methods used include distance

transformations, citing the known works of Borgefors and Mitchell with respect to mobile objects and Euclidean distance transformations using various methods, including applying a chamfer mask to the obtained digital map data for terrain navigation. As previously stated, Zoraster does include using distance transforms to determine an optimal (shortest timewise) path to a target. Zoraster also includes the scanning methods, as embodied in claim 1.

The Examiner cited Mitchell 1986 reference provides a more detailed algorithm for discerning the shortest path in a given environment. Mitchell 1986 teaches a method for estimating distances from a mobile object, including wherein the object is subjected to static constraints, prohibiting it from certain zones of the map, and suggests dynamic constraints whose configuration varies as a function of time. Further, Mitchell 1986 teaches the map being extracted from a terrain elevation database, including a set of points labeled by altitude, longitude, and latitude. Mitchell 1986 adds the embodiment wherein a distance transform is implemented operating by propagation of a mesh, which is arranged in rows and columns, over the obtained digital map. Mitchell 1986 also adds time constraints, assigning the proximity to the source point a zero value, and excluding an impermissible goal point from the search algorithm.

Thus, since both inventions both disclose/teach similar elements and usage, it would have been obvious to one of ordinary skill in the art at the time of the invention to simply substitute one apparatus into the other, or at least combine their respective elements, to achieve no more than the predictable result of a method for estimating distances on a DTED map for use in navigating a mobile object over points in a terrain.

Combining prior art elements according to known methods to yield predictable results is a rationale to support a conclusion of obviousness. See MPEP 2143(A).

Simple substitution of one known element for another to obtain predictable results will support a conclusion of obviousness. See MPEP 2143 (B).

Still, while the above combination suggests dynamic constraints, it is not explicit in its detail.

Tran teaches a ground collision avoidance system that exhibits improved accuracy and performance by integrating with all other aircraft systems including guidance systems, navigation systems, digital terrain elevation databases, mission computers, and radar altimeters. The ground collision avoidance system fully utilizes active onboard sensors in combination with the knowledge of terrain and obstacle data contained in databases. Furthermore, the ground collision avoidance system provides a multiple processing path to determine numerous predicted flight paths based on a number of reasonable assumptions regarding the aircraft flight during a predetermined amount of time. By using predictive flight path schemes a realistic estimate of the predicted flight path envelope can be determined and then this information can be used in conjunction with accurate terrain elevation databases to determine whether a ground collision condition exists. On the basis of these calculations, appropriate warnings can be provided to the air crew as well as suggested maneuvers to avoid ground collision (abstract).

Further, Tran discloses that an adaptive ground collision avoidance system that employs a continuously-updated digital terrain elevation database in order to provide an accurate analysis of the terrain over which an aircraft is flying. This local terrain awareness system incorporates a

digital terrain elevation database along with inputs from active terrain sensors, radar altimeter, as well as the inertial navigation system. The combination of these elements provides an accurate depiction of the terrain directly under and along the flight path of the aircraft. Because the database is continually updated by the radar altimeter and other active sensors, the accuracy of the database is not of a concern because it is continually augmented. By augmenting the information already contained in the database, a more accurate picture over a large area of the terrain over which the aircraft is flying can be generated. The accuracy of the terrain model does not change as the aircraft moves away or closer to the aircraft, because the model is continuously updated due to the inputs of the active sensors. Additionally, the database is able to account for newly-erected structures on the ground, which may have been erected since the database was constructed. The ground collision avoidance system provides numerous predicted flight paths for the aircraft based on a reasonable number of assumptions regarding the aircraft flight during a predetermined amount of time. Initially, a first flight path is determined for the aircraft as it flies along its current route. A second/recommended route is calculated for the aircraft that would allow the aircraft to avoid any obstacle along the first path with which the aircraft would otherwise collide. Instead of the ground collision avoidance detector being a mere proximity detector to terrain which can be collided with, it instead allows the aircraft to realize that it has an exit route, and the collision warning notification is then not given until the absolute last minute. The recommended route is provided to the pilot as an automatic guidance feature. As soon as it is determined that the escape route is to disappear, the ground collision warning is then made and a proposed course of escape is provided to the pilot (column 2 lines 25-65).

Thus, Tran has provided an anti-collision invention which estimates a distance to a known point on a map, the point being realized from a continuously updated terrain elevation database comprising position (GPS, see column 2 lines 13-24) and altitude data from the DTED, as mentioned by Mitchell. Based on the distance to the target of the aircraft (column 6 lines 14-42), and predicted collision ETA, the aircraft provides the safest route that would keep the aircraft from the prohibited zone of travel. Further, in the above citations, Tran explicitly teaches wherein the mobile object is subject to dynamic constraints prohibiting it from certain zones of the map, these constraints changing with the flight characteristics of the aircraft.

All inventions above are drawn toward utilizing perceived information combined with terrain databases for terrain awareness/navigation. All of the components and methods are known in the above prior art. The only difference is a combination of these elements into a single device.

Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to incorporate the dynamic constraints as taught by Tran onto the combination of Zoraster and Mitchell 1986, since all systems could be used in combination to produce the predictable result of continually altering the mobile objects traveling situation to reflect its changing environment while providing the shortest path to a goal point.

Combining prior art elements according to known methods to yield predictable results is a rationale to support a conclusion of obviousness. See MPEP 2143(A).

Regarding claims 2-4, Zoraster, Mitchell 1986, and Tran, as combined above in claim 1, teaches that the method includes forecasting aircraft position with the flight plan, and that if the deviation between a minimum safe altitude and an object is beyond an unacceptable threshold, detecting a warning situation.

Further, Tran teaches that the flight envelope prediction system 50 coordinates with the flight control computers 35, mission computer 24 and the inertial navigation systems 28 to provide one or more predicted flight envelopes within which the aircraft will be traveling during a predetermined period. Flight envelope prediction system 50 calculates a number of reasonable flight envelopes based on the extended current flight trajectory and the possible maneuvers that a pilot is likely to carry out. Flight envelope prediction system 50 also operates with the high fidelity aircraft model 39 (including flight control and guidance models) to accurately predict the possible maneuvering capabilities of the aircraft.

Ground correlation system 60 utilizes the information provided by localized terrain awareness system 40 and flight envelope prediction system 50 to ground map the aircraft's flight. This ground mapping is accomplished by projecting the possible flight paths upon the correlated terrain and feature image over which the aircraft is flying. From this ground correlation a warning situation can be detected wherein it is determined that ground collision is imminent if no further corrective action is taken (column 5 lines 33-55).

Regarding claim 10, Zoraster, as modified above by Mitchell 1986 and Tran, combined with the well known work of Borgefors, teaches all eight scanning techniques (taken from current application, para 0007):

"...the scanning of the image pixels the image being analyzed from left to right row by row and from top to bottom, and inverse lexicographic order, or transposed lexicographic order, the image having undergone a 90.degree. rotation, and inverse transposed lexicographic order. She also proposes the adoption of a chamfer mask of dimensions 3.times.3 with two values (3, 4) of neighborhood distances or of dimensions 5.times.5 with three values (5, 7, 11) of neighborhood distances."

Thus, it would have been obvious to one of ordinary skill in the art of the invention to utilize the image possessing techniques as taught by Zoraster, Mitchell 1986, and Tran in combination to yield the predictable result of distance stabilization via multiple scanning techniques.

4. Claims 5 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Zoraster, Mitchell 1986, and Tran, as applied to claims 1 and 6 above, and further in view of Margolin (US 6,177,943)

Regarding claims 5 and 11, Tran, as combined with Zoraster and Mitchell 1986, teaches that a ground collision warning generator 80 provides the necessary warnings and displays to the pilot and air crew to alert them to possible ground collision and provides them with the visualized vertical terrain profile and, predicted flight path, and highlighted collision point (see FIGS. 2 and 5 for ground collision point as represented on the terrain scanning profile). Ground collision warning generator 80 has attached thereto audio warnings system 82 and a ground collision warning display 84. Audio warnings system 82 provides audible warnings to the pilot such as buzzers or possible "fly out" cueing commands. The buzzers can be variable frequency

tone and distinctive voice advisories and warnings for various/different ground proximity, ground collision, and ground avoidance situations. Similarly, ground collision warning display 84 can display the possible collision situations to the pilot as well as display the necessary evasive maneuvers to assist the pilot in avoiding ground collision (column 5 lines 63-67, column 6 lines 1-14). While this suggests that when the deviations of the aircraft, with respect to the ground, go beyond a threshold display means can provide a visual indication on a map, it still does not explicitly teach that which is claimed. Further, the above combination does not teach scanning the image pixels in a diagonal order.

Margolin, however, teaches that to prevent a polygon from blending in with its neighbors in a system with a limited number of bits per pixel, polygons can be drawn so that its edges are a different color or shade from its interior (column 9 lines 66-67, column 10 lines 1-2).

Further, Margolin teaches scanning saved terrain images in successive patterns, including a diagonal order (column 2 lines 61-67, column 3 lines 1-11).

All of the components and methods are known in the above prior art. The only difference is a combination of these elements into a single device.

Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to incorporate the use of color strata function of Margolin onto the combination of Zoraster, Mitchell 1986, and Tran, since all systems could be used in combination to produce the predictable result of displaying terrain deviation data via the use of color, as well as a diagonal method of scanning an image diagonally to obtain greater distance estimate stabilization.

Combining prior art elements according to known methods to yield predictable results is a rationale to support a conclusion of obviousness. See MPEP 2143(a).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JONATHAN M. DAGER whose telephone number is (571)270-1332. The examiner can normally be reached on 0830-1800 (M-F).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jack Keith can be reached on 571-272-6878. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

JD
27 April 2009

/Jack W. Keith/
Supervisory Patent Examiner, Art Unit 3663